

## **SECTION 404**

### **WHOLE-BUILDING PERFORMANCE ALTERNATIVE**

**404.1 Scope.** This section establishes criteria for compliance using whole-building performance analysis. Such analysis shall include heating, cooling and service water heating energy

**404.2 Mandatory requirements.** Compliance with this Section requires that the criteria of Sections 401, 402.4 and 402.5 be met.

**404.3 Performance based compliance.** Compliance based on whole building performance requires that a proposed residence (Proposed Design) be shown to have an annual energy cost that is less than or equal to the annual energy cost of the Standard Reference Design. Energy prices shall be taken from a source approved by the official, such as the Department of Energy, Energy Information Administration's State Energy Price and Expenditure Report. The code official shall be permitted to require time-of-use pricing.

#### **404.4 Documentation**

**404.4.1 Compliance software tools.** Documentation verifying that the methods and accuracy of the compliance software tool conform to the provisions of this Section, shall be provided to the code official.

**404.4.2 Inspection checklist.** A checklist documenting all of the building component characteristics of the Proposed Design as given in Table 404.1.1 shall be submitted with the compliance documentation. This inspection checklist shall show the estimated annual energy cost for both the Standard Reference Design and the Proposed Design.

**404.4.3 Additional documentation.** The code official shall be permitted to require the following documents:

- (a) Documentation of the building component characteristics of the Standard Reference Design.
- (b) A certification signed by the builder providing all of the building component characteristics of the Proposed Design as given in Table 404.1.1.

#### **404.5 Calculation procedure.**

**404.5.1 General.** Except as specified by this Section, the Standard Reference Design and Proposed Design shall be configured and analyzed using identical methods and techniques.

**404.5.2 Residence specifications.** The Standard Reference Design and Proposed Design shall be configured and analyzed as specified by Table 404.1.1. Table 402.1.2 shall include by reference all notes contained in Table 402.1.1.

**Table 404.1.1 Specifications for the Standard Reference and Proposed Designs**

<b>Building Component</b>	<b>Standard Reference Design</b>	<b>Proposed Design</b>
Above grade walls:	Type: wood frame Gross area: same as proposed U-Factor: from Table 402.1.2 Solar absorptance = 0.75 Emittance = 0.90	As proposed As proposed As proposed As proposed As proposed
Basement and crawlspace walls:	Type: same as proposed Gross area: same as proposed U-Factor: from Table 402.1.2	As proposed As proposed As proposed
Above grade floors:	Type: conventional wood frame Gross area: same as proposed U-Factor: from Table 402.1.2	As proposed As proposed As proposed
Ceilings:	Type: conventional wood frame Gross area: same as proposed U-Factor: from Table 402.1.2	As proposed As proposed As proposed
Roofs:	Type: composition shingle on wood sheathing Gross area: same as proposed Solar absorptance = 0.75 Emittance = 0.90	As proposed As proposed As proposed As proposed
Attics:	Type: vented with aperture = 1ft <sup>2</sup> per 300 ft <sup>2</sup> ceiling area	As proposed
Foundations:	Type: same as proposed	As proposed
Doors:	Area: 40 ft <sup>2</sup> Orientation: North U-factor: same as fenestration from Table 402.1.2	As proposed As proposed As proposed
Fenestrations:	Total area <sup>2</sup> = 18% of conditioned floor area Orientation: equally distributed to four (4) cardinal compass orientations (N,E,S,&W) U-factor: from Table 402.1.2 SHGC: from Table 402.1.2 except that for climates with no requirement (NR) SHGC = 0.68 shall be used Interior shade coefficient:	As proposed As proposed As proposed As proposed Same as Standard Reference <sup>1</sup>

Building Component	Standard Reference Design	Proposed Design
	Summer = 0.70 Winter = 0.85 External shading: none	As proposed
Infiltration:	Normalized leakage of 0.57 times the Weather Factor determined in accordance with ASHRAE Standard 136	Same as Standard Reference except where post construction blower door testing is conducted in accordance with ASTM E 779 and a continuous mechanical ventilation system is specified by the Proposed Design <sup>2</sup>
Mechanical ventilation: <sup>3</sup>	None, except where continuous mechanical ventilation is specified by the Proposed Design, in which case:  Annual vent fan energy use: $\text{kWh/yr} = 0.03942 \cdot \text{CFA} + 29.565 \cdot (\text{N}_{\text{br}} + 1)$ where: CFA = conditioned floor area $\text{N}_{\text{br}}$ = number of bedrooms	As proposed <sup>3</sup>  As Proposed
Internal gains:	$\text{IGain} = 17,900 + 23.8 \cdot \text{CFA} + 4104 \cdot \text{N}_{\text{br}}$ (Btu/day per dwelling unit)	Same as Standard Reference
Internal mass:	An internal mass for furniture and contents of 8 pounds per square foot of floor area.	Same as Standard Reference
Structural mass:	For masonry floor slabs, 80% of floor area covered by R-2 carpet and pad, and 20% of floor directly exposed to room air; For masonry basement walls, as proposed, but with insulation required by Table 402.1.2 located on the interior side of the walls; For other walls, for ceilings, floors, and interior walls, conventional wood frame construction.	As proposed  As proposed  As proposed

Building Component	Standard Reference Design	Proposed Design
Heating systems <sup>4,5</sup>	Fuel type: same as Proposed Design Efficiencies: Electric: heat pump with prevailing federal minimum efficiency Non electric furnaces: natural gas with prevailing federal minimum efficiency Non electric boilers: natural gas boiler with prevailing federal minimum efficiency Capacity: sized in accordance with Section 1401.3 of the International Mechanical Code	As proposed <sup>5</sup>  As proposed  As proposed  As proposed  As proposed
Cooling systems <sup>4,6</sup>	Fuel type: Electric Efficiency: in accordance with prevailing federal minimum standards Capacity: sized in accordance with Section 1401.3 of the International Mechanical Code	As proposed <sup>6</sup> As proposed  As proposed
Service water heating systems <sup>4,7</sup>	Fuel type: same as Proposed Design Efficiency: in accordance with prevailing federal minimum standards Use (gal/day): $30 + 10 \cdot N_{br}$ Tank temperature: 120 F	As proposed <sup>7</sup>  As proposed  Same as Standard Reference Same as Standard Reference
Thermal distribution systems:	A thermal distribution system efficiency (DSE) of 0.80 shall be applied to both the heating and cooling system efficiencies.	Same as Standard Reference, except when tested in accordance with ASHRAE Standard 152 and then either calculated through hourly simulation, or calculated in accordance with ASHRAE Standard 152, or as specified by Table 404.1.2.

Building Component	Standard Reference Design	Proposed Design
Thermostat	Type: manual, cooling temperature set point = 78 F; heating temperature set point = 68 F	Same as Standard Reference

**Notes:**

- For fenestrations facing within 15 degrees of due south that are directly coupled to thermal storage mass, the winter interior shade coefficient shall be permitted to be increased to 0.95 in the Proposed Design.
- For homes with basements and for multi-family attached homes the following formula shall be used to determine total window area:

$$A_F = 0.18 \times A_{FL} \times F_A \times F$$

where:

$A_F$  = Total fenestration area.

$A_{FL}$  = Total floor area of directly conditioned space.

$F_A$  = (Above grade thermal boundary gross wall area)/(above grade boundary wall area + 0.5 x below grade boundary wall area).

$F$  = (Above grade thermal boundary wall area)/(above grade thermal boundary wall area + common wall area)  $\geq 0.56$

and where:

*Thermal boundary wall* is any wall that separates conditioned space from unconditioned space or ambient conditions.

*Above grade thermal boundary wall* is any thermal boundary wall component not in contact with soil.

*Below grade boundary wall* is any thermal boundary wall in soil contact.

- For Proposed Designs that specify a mechanical ventilation system, the Standard Reference Design shall include the specified annual mechanical ventilation fan energy use and the Proposed Design shall use the specified energy use of the proposed mechanical ventilation system. For the proposed Design, the combined infiltration and mechanical ventilation rate shall be the sum of the infiltration rate tested in accordance with ASTM E 779 plus the specified mechanical ventilation rate but shall not be less than  $0.03 \times \text{CFA} + 7.5 \times \text{Nbr (cfm)}$ .
- For a Proposed Design with multiple heating, cooling or water heating systems using different fuel types, then the applicable Standard Reference home system capacities and fuel types shall be weighted in accordance with the loads distribution (as calculated by accepted engineering practice for that equipment and fuel type) of the subject multiple systems.
- For a Proposed Design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the Standard Reference Design and Proposed Design. For electric heating systems the prevailing federal minimum efficiency heat pump shall be selected.
- For a Proposed Design home without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the Standard Reference Design and the Proposed Design.
- For a Proposed Design with a non-storage type water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency with the same fuel as the predominant heating fuel type shall be assumed for the Proposed Design. For a Proposed Design without a proposed water heater, a 40-gallon storage-type water heater with the minimum NAECA Energy Factor with the same fuel as the predominant heating fuel type shall be assumed for both the Proposed and Standard Reference Designs.

**Table 404.1.2 Default Distribution System Efficiencies for Proposed Designs <sup>1</sup>**

Distribution System Configuration and Condition:	Forced Air Systems	Hydronic Systems <sup>2</sup>
Distribution system components located in <i>unconditioned</i> space	0.80	0.95
Distribution systems entirely located in <i>conditioned</i> space <sup>3</sup>	0.88	1.00
<i>Proposed</i> “leak free” with entire air distribution system located in the <i>conditioned</i> space <sup>4</sup>	0.96	
<i>Proposed</i> “leak free” air distribution system with components located in the <i>unconditioned</i> space	0.88	
“Ductless” systems <sup>5</sup>	1.00	

**Notes:**

1. *Default values* given by this table are for distribution systems as proposed, and which meet minimum requirements for duct system insulation.
2. *Hydronic systems* shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed loop piping and that do not depend on ducted, forced air flows to maintain space temperatures.
3. *Entire system in conditioned space* shall mean that no component of the distribution system, including the air handler unit, is located outside of the conditioned space.
4. *Proposed “leak free”* shall mean *substantially leak free* to be a leakage rate of not more than 5% of the rated fan flow rate at a pressure differential of 25 Pascal across the entire system, including the manufacturer’s air handler enclosure. This *proposed condition* must be specified as the required performance in the construction documents. This proposed condition *requires confirmation through field-testing* of installed systems.
5. *Ductless systems* may have forced airflow across a coil but shall not have any ducted airflows external to the manufacturer’s air handler enclosure.

#### **404.6 Calculation software tools.**

**404.6.1 Minimum capabilities.** Calculation procedures used to comply with this Section shall be computer-based software tools capable of calculating the annual energy consumption of all building elements that differ between the Standard Reference Design and the Proposed Design and shall include the following capabilities:

- a. Computer generation of the Standard Reference Design residence using only the input for the Proposed Design residence. The calculation procedure shall not allow the user to directly modify the building component characteristics of Standard Reference Design residence.
- b. Calculation of whole-building, single-zone sizing for the heating and cooling equipment in the Standard Reference Design residence in accordance with Section 1401.3 of the International Mechanical Code.
- c. Calculations that account for the indoor and outdoor temperature dependencies and the part load performance of heating, ventilating and air conditioning equipment based on climate and equipment sizing.
- d. Printed code official inspection checklist listing each of the Proposed Design building components from Table 404.1.1 determined by the analysis to provide compliance along with their respective performance rating (e.g. R-Value, U-Factor, SHGC, HSPF, AFUE, SEER, EF, etc.).

**404.6.2 Approved tools.** Performance analysis tools shall be approved by the code official. Tools may be approved based on meeting a specified threshold for a jurisdiction, such as an accredited home energy rating system (HERS) tool. The code official shall be permitted to approve tools for a specified application or limited scope.

**404.6.3 Input values.** When calculations require input values for building elements, other those regulated by Sections 402, 403 and 404, those input values shall be taken from a source approved by the code official.